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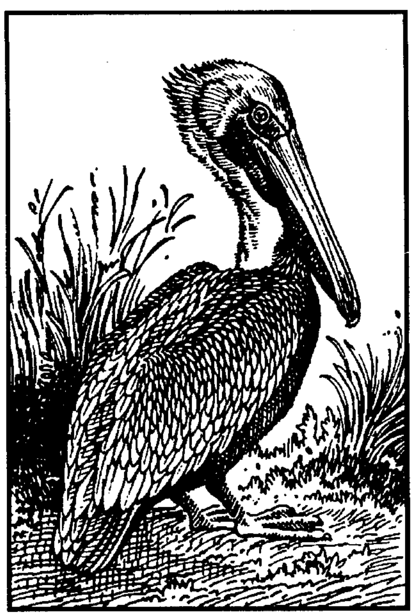
Wetlands Research Program Technical Report WRP-SM-11

Larval Fish Dynamics in Oxbow Lakes with Varying Connections to a Temperate River

by K. Jack Killgore, Gary L. Miller



September 1995 – Final Report

The following two letters used as part of the number designating technical reports of research published under the Wetlands Research Program identify the area under which the report was prepared:

	Task		Task
CP	Critical Processes	RE	Restoration & Establishment
DE	Delineation & Evaluation	SM	Stewardship & Management

Wetlands Research Program

Technical Report WRP-SM-11
September 1995

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by K. Jack Killgore

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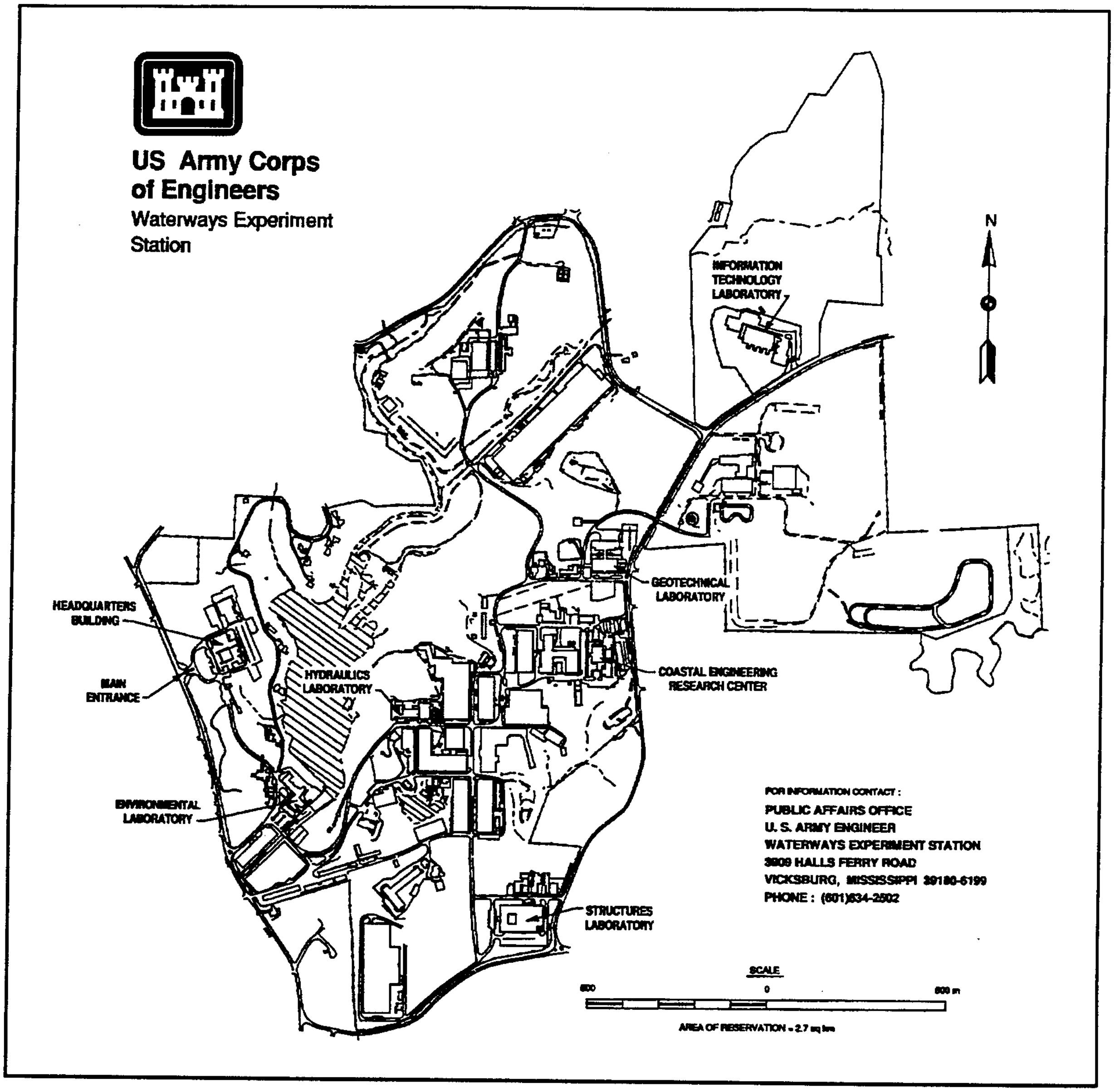

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Fisheries Habitat

Larval Fish Dynamics in Oxbow Lakes with Varying Connections to a Temperate River (TR WRP-SM-11)

ISSUE:

Hydrologic connectivity between floodplain and river is a wetland management consideration. Floodplains that border channelized rivers often become isolated due to sedimentation, levees, or water level manipulation from water control structures. Re-establishing connectivity of permanent floodplain water bodies can promote species richness by providing spawning and rearing habitat for laterally migrating fish and contribute to the overall ecological function of river systems.

RESEARCH:

Composition and relative abundance of larval fish were compared among three oxbow lakes that occur on the floodplain of the Tallahatchie River, Mississippi. Each lake represented different levels of connectivity with the river: permanently isolated, seasonally connected, and permanently connected.

SUMMARY:

Water elevation, temperature, and dissolved oxygen are relatively stable in oxbow lakes compared to the river. At least 11 species of larval fish were collected in the oxbow lakes, collectively; spatial distribution was nonuniform. Degree of connectivity influenced presence of certain species, suggested that species composition of oxbow lakes may be managed to a certain extent by regulating access from river to lake.

AVAILABILITY OF REPORT:

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About the Authors:

Dr. K. Jack Killgore is a fisheries biologist at the WES Environmental Laboratory. Dr. Gary L. Miller is an associate professor of biology at the University of Mississippi, Oxford. Point of contact at WES is Dr. Killgore at (601) 634-3397.

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Preface

The work described in this report was authorized by Headquarters, U.S. Army Corps of Engineers (HQUSACE), as part of the Stewardship and Management Task Area of the Wetlands Research Program (WRP). The work was performed under Work Unit 32766, Wetland Stewardship and Management Demo Areas, for which Mr. Chester Martin was the Technical Manager. Ms. Denise White (CECW-ON) was the WRP Technical Monitor for this work.

Mr. David Mathis (CERD-C) was the WRP Coordinator at the Directorate of Research and Development, HQUSACE; Dr. William L. Klesch (CECW-PO) served as the WRP Technical Monitor's Representative; Dr. Russell F. Theriot, U.S. Army Engineer Waterways Experiment Station (WES), was the Wetlands Research Program Manager. Mr. Martin was the Task Area Manager.

The report was prepared by Dr. K. Jack Killgore, WES, who also was the Principal Investigator for the study, and Dr. Gary L. Miller, University of Mississippi. The work was performed under the general supervision of Dr. Edwin Theriot, Chief, Aquatic Ecology Branch, and now Acting Assistant Director, EL; Dr. Conrad J. Kirby, Chief, Ecological Research Division; and Dr. John W. Keeley, Director, EL.

The following individuals assisted in the field and laboratory: Tom Turner, Kari Benson, Micky Eubanks, Ken Kallies, Chester Figiel, Ken Floyd, Mike Gooch, and Ed Toyer. Dr. Jan Hoover, WES, provided constructive comments on earlier drafts of the manuscript.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
feet per mile	0.19	meters per kilometer

1 Introduction

Background

Bottomland hardwood wetlands occur on alluvial floodplains of many river systems in the lower Mississippi River basin. These forested wetlands are inundated in winter and spring, they are highly productive, and most support diverse fish communities (Finger and Stewart 1987; Scott and Nielson 1989; Baker and Killgore 1994).

Between 75 and 100 species of fish complete one or more of their life stages (i.e., egg, larvae, juvenile, adult) in bottomland hardwood wetlands (Baker et al. 1991; Leitman et al. 1991; Baker and Killgore 1994). Common groups of fishes include gars, minnows and shiners, suckers, catfishes, sunfishes, and darters.

Floodplain Habitat

There is a temporal trend in the appearance of larval fish species in the wetland that is usually associated with onset, duration, and magnitude of flooding (Finger and Stewart 1987; Copp and Cellot 1988; Baker and Killgore 1994; Hoover, Konicoff, and Killgore 1995). Some fishes migrate to riverine floodplains in spring to spawn on inundated vegetation, on leaf litter, or near woody debris (Robison and Buchanan 1988). The larvae often remain on the floodplain for extended periods feeding on plankton (Becker 1988; Wallus, Simon, and Yeager 1990). Other species spawn and reside as adults in the more permanent floodplain habitats throughout the year.

Regularly flooded stream systems in the lower Mississippi River basin typically include five distinct floodplain habitats, each of which can be delineated from satellite imagery or low-altitude aerial photography (Killgore and Hoover 1993). Three are seasonally flooded: cultivated agricultural land, fallow land, and bottomland hardwood forest; two are permanent water bodies: oxbow lakes and an aggregate of scatters, brakes, and mouths of tributaries. This study focuses on importance of oxbow lakes as rearing habitat for fishes.

Oxbow Lakes

Oxbow lakes are former river channels. They can be permanently connected, seasonally contiguous, or permanently isolated from the main river, but retain water year-round. The shoreline is typically wooded, and brush is abundant in the water near shore and ends of the lake. Oxbow lakes comprise nearly 10 percent of the nonchannel aquatic habitat (during low water) of the lower Mississippi River Drainage (Baker, Killgore, and Kasul 1991). In many respects (e.g., stratification, large surface area, permanence), these lakes are more typical of deep isolated lakes than floodplain habitats. Nevertheless, those connected to main river channels either continuously or during floods could function as important fish nursery areas (Beecher, Hixson, and Hopkins 1977). Understanding the relationship between riverine-floodplain connections and larval fish abundance is critical to making management decisions in riverine systems.

Larval fish in oxbow lakes of the Tallahatchie River floodplain, a principal tributary of the Yazoo River, Mississippi, were studied. Over 100 oxbow lakes occur along the Tallahatchie River and most are connected to the river at least once every 2 years (Killgore and Hoover 1993). The majority of the floodplain has been converted to cultivated agricultural land, and previous flood control projects have reduced duration of flooding. Thus, permanent floodplain water bodies, such as oxbow lakes, may serve as important spawning and rearing sites when water elevation declines. Oxbow lakes that remain contiguous with the river during at least part of the reproductive season provide habitat where fish can freely move between floodplain and river. Oxbow lakes that remain isolated are often managed for recreational fisheries, particularly largemouth bass.[1]

Study Objectives

Objectives of this study were to address three questions regarding larval fish dynamics in oxbow lakes with varying degree of connection to the Tallahatchie River drainage:

- What are the abundant larval fishes during spring floods?
- How do chronologies of larval fishes differ?
- Are there spatial patterns of larval fish abundance within oxbow lakes?

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[1] Personal communication, Gary Lucas, Keith Meals, Mississippi Department of Wildlife, Fisheries, and Parks.

2 Description of Study Site

Yazoo River Delta

The study area lies within the alluvial valley (delta) of the upper Yazoo River Basin. Terrain in the delta is flat with an average slope from north to south of 0.5 ft per mile[1] (U.S. Army Engineer District, Vicksburg 1975). Rivers are meandering; they have deep, swift river channels and areas of slackwater associated with sandbars and cut banks, as well as some man-made features (Panola-Quitman Waterway). River flow is controlled by hypolimnetic releases from flood control reservoirs. Thus, higher river stages exist during the summer and fall than would naturally occur. Substrate is composed of sand or clay and most instream cover consists of fallen trees or live willow trees.

Agricultural land is the dominant floodplain habitat. Extensive inundation of the floodplain occurs each spring; the magnitude of flooding depends on local rainfall and releases from the flood control reservoirs. Channel maintenance and levee construction occurred in the majority of rivers and tributaries in the study area during the 1940's and 1950's.

Tallahatchie Oxbow Lake Sites

Three oxbow lakes in Tallahatchie and Quitman Counties, Mississippi, were chosen for the study based on likelihood of connection with the main river during spring floods and accessibility by boat (Figure 1). Surface area of each lake was approximately 30 to 32 ha. Low water prevailed through the 1993 sampling period compared with the previous 5 years (Figure 2).

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1 A table of factors for converting U.S. customary units of measurement to SI is presented on page vii.

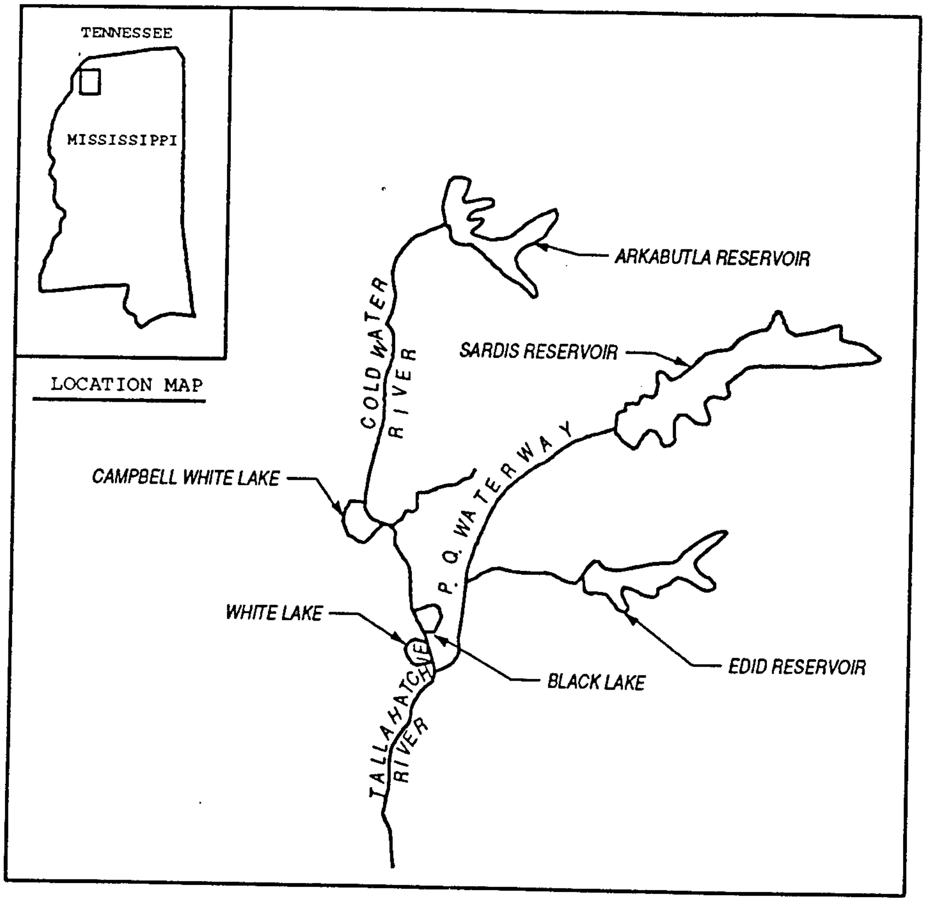

Figure 1. Oxbow lakes studied in the Tallahatchie River System. Black Lake is isolated, Campbell White Lake is seasonally connected, and White Lake is permanently connected to the river

River Connections

Black Lake is located near the Tallahatchie River in Quitman Co. just north of the Quitman-Tallahatchie county line. The lake is situated farthest from the river and is topographically isolated from the Tallahatchie River channel. Brief connections with the river may have occurred during 1991, however (Figure 2). Campbell White Lake is located along the Coldwater River (i.e., upper reach of the Tallahatchie River) in Quitman Co. approximately 1 mile north of the confluence of the Coldwater and the Little Tallahatchie Rivers. Both the northern and southern ends of Campbell White Lake lie close to the Coldwater River and were connected to the river channel for the first two sampling periods. In previous years, this lake was connected to the river during spring floods but becomes isolated as river stages decline. White Lake is situated north of the confluence of the Tallahatchie River and the Panola-Quitman Waterway in Tallahatchie Co. Except during low water, the lake is connected at the south end by a channel to the Tallahatchie River.

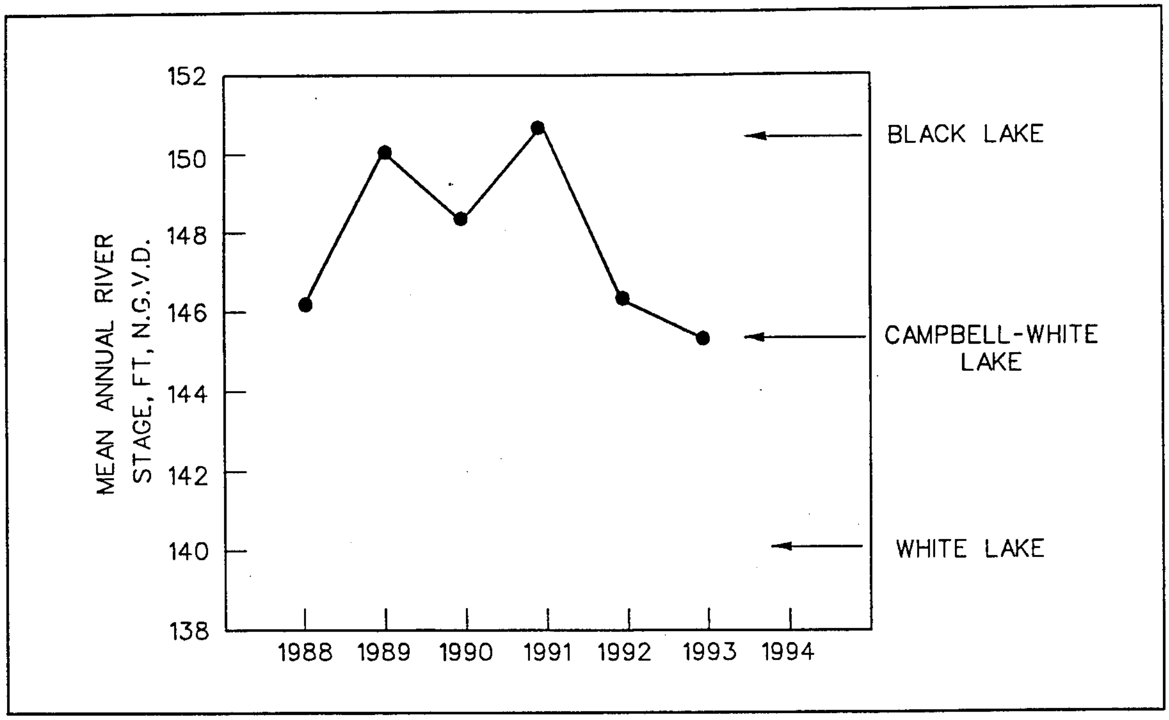

Figure 2. Hydrograph of mean annual stage of Coldwater/Tallahatchie River at Marks, Mississippi, indicating approximate stage at connection for Black (isolated), Campbell White (seasonally connected), and White (permanently connected) Lakes. (Stages are in feet referenced to the National Geodetic Vertical Datum.)

3 Methods

Fish Collections

Eight collections at approximately 7-day intervals were made in each lake between 2 April and 21 May 1993. Because of low water, no collections were made in Campbell White Lake and White Lake after 21 May and, thus, the study was concluded. Each sampling period extended over 3 days (two nights); two lakes were sampled one night and the third the following night.

Three locations within each lake were designated as follows:

a. *Near end* -- position near connection to channel (in the case of White and Campbell White Lakes) or boat ramp (in the case of Black Lake).

b. *Middle* -- position at the apex of the oxbow.

c. *Far end* -- location at the end farthest from the connection or ramp.

Surface temperature (°C), water velocity (m/s), and dissolved oxygen (mg/ℓ) were measured near the middle trap when traps were set (late afternoon) at each location, in each lake, during each collection period. Temperature was recorded with a hand-held probe, water velocity was measured with a Model 201 Marsh-McBirney Flow Meter, and dissolved oxygen was determined by titration using a Hach Kit.

Equipment

Three 30- by 30- by 30-cm Plexiglas larval light traps (Killgore 1994) were placed in each of the three locations in each lake. Each trap was placed in water 1.5 to 2.0 m in depth. The traps at a location within the lake were usually placed perpendicular to the shoreline and separated by more than 20 m. Previous studies (Miller and Trexler 1991; Turner et al. 1994) suggest that such trap separation is sufficient to prevent significant interactions among traps. Chemical light sticks (Cyalume yellow, 12-hr illumination) were placed inside each trap as an attractant for fishes. Traps were illuminated shortly

before sunset and recovered the following morning. Trap contents were poured through a 425-μ plankton net and field preserved in 10-percent formalin. Total number of samples was 216, 72 for each lake.

Fish Identification

Fishes were identified from trap samples to the lowest taxonomic category using available larval fish keys (Houge, Wallus, and Kay 1976; Auer 1982; Fuiman et al. 1983). Groups that are speciose (centrarchids, cyprinids, and percids) present special problems in that the larvae were difficult to identify to species with any reliability. For those taxa, specimens were identified to genus with the exception of *Cyprinella* and *Notropis,* collectively referred to as Cyprinids, and *Etheostoma* and *Percina,* collectively referred to as Percids. Fishes that exhibited fully differentiated fins were classified as juveniles (Balon 1975). Larvae and juveniles were treated as separate taxa.

Fish abundance data were log transformed and were reported as mean catch per unit effort for the lake or the region of the lake being compared. Diversity and evenness of the fish assemblages were compared among lakes. Diversity was calculated using the Shannon function H' (Magurran 1988). H' ranges from 0.0 when a single species is present, to 1n [total number of species]. Evenness E expresses equitability in abundance and is calculated as the ratio of observed diversity to maximum diversity. Values range from 0.0 (single species numerically dominant) to 1.0 (all species are equally abundant).

4 Results

Physical Data

No detectable flow was observed at any site during the study. Mean annual river stage was low compared with the previous 5 years (Figure 2). Mean surface temperature did not differ appreciably (more than 1 °C) among the three locations (near end, middle, far end) of any of the three lakes sampled. Thus, data are pooled among locations (Table 1). Dissolved oxygen data were pooled among locations in the lake for the same reason (Table 1).

Table 1
Average (Standard Error) of Surface Temperature (°C) and Dissolved Oxygen (DO) (mg/ℓ at 0.5 m Depth) for Three Oxbow Lakes in Northern Mississippi, Spring 1993

	Black Lake		White Lake		Campbell White Lake	
Date	Temp	DO	Temp	DO	Temp	DO
2 April	19.1(0.3)	7.2(0.3)	18.3(0.4)	6.5(0.7)	20.1(0.8)	7.1(0.3)
9 April	19.8(0.8)	6.9(0.8)	18.9(0.5)	7.1(0.8)	19.2(0.3)	6.4(0.4)
15 April	20.1(0.6)	7.3(0.6)	21.2(0.3)	7.1(0.2)	19.9(0.5)	7.9(0.3)
22 April	20.5(0.9)	7.0(0.5)	20.9(0.9)	8.1(0.6)	21.2(0.4)	7.8(0.7)
29 April	22.0(0.7)	6.2(0.6)	21.3(0.3)	6.5(0.2)	22.0(0.3)	6.3(0.6)
7 May	24.0(0.5)	6.4(0.7)	22.5(0.7)	5.9(0.5)	23.3(0.6)	6.0(0.7)
13 May	23.0(0.5)	5.8(0.3)	24.0(0.5)	5.3(0.1)	23.1(0.1)	5.7(0.3)
21 May	23.4(0.6)	6.0(0.6)	24.3(0.2)	5.3(0.3)	24.1(0.5)	5.6(0.3)

Temperature was similar among the lakes, rising slowly during the sampling period. Dissolved oxygen was always greater than 5.0 mg/ℓ and remained relatively constant, which is consistent with that observed for flooded forests, fields, and backwater channels in the Tallahatchie River (Miller and Trexler 1991; Benson, unpublished data).

Species Composition

A total of 3,814 larval and 436 juvenile fish from 11 different taxa were collected during the study (Table 2). There were no appreciable differences in the total number of larval fish caught during the study in the three lakes.

Nine, ten, and ten taxa were represented among the larval fish collected in the isolated lake (Black), seasonally connected lake (Campbell White), and permanently connected lake (White), respectively (Table 2). Species diversity and evenness were highest in the permanently connected lake (Figure 3). For larval fish, diversity and evenness were similar between isolated and seasonally connected lakes. For larval and juvenile fish, diversity and evenness were most similar between permanently and seasonally connected lakes.

The three lakes differ in the relative representation of the most common taxa found in the study. Larval *Pomoxis* was the most common taxon collected in Black and White Lakes whereas *Dorosoma cepedianum* was most common in Campbell White Lake. Larval minnows were uncommon in Campbell White Lake but represented the second and third most common taxa collected in Black Lake and White Lake, respectively. Larval *Ictiobus* were collected in small numbers in the two lakes with connections to the main river channel (White Lake and Campbell White Lake). Larval *Micropterus* were collected only in the isolated lake (Black Lake).

Temporal Patterns

Temporal abundance of the four most common taxa differed among the three lakes (Figure 4) with the isolated lake (Black) most dissimilar. Larval cyprinids and *Pomoxis* were collected several weeks earlier and were found over a longer period of time in the isolated lake than in the connected lakes. Larval abundance of *D. cepedianum* was later and less pronounced in the isolated lake. *Pomoxis* larvae were most abundant 22 April in all lakes; and in the isolated and permanently connected lakes, there was a secondary peak mid-May. The abundance of larval *D. cepedianum* and *Pomoxis* remained high through the spring in the permanently connected lake. The shortest duration of larval fish occurrence was in the seasonally connected lake. Other notable taxa appeared in collections for only a short period: *Ictiobus* in the connected lakes (N = 3, 15-16 April; N = 19, 22-23 April) and *Micropterus* in the isolated lake (N = 3, 15-16 April; N = 27, 29-30 April).

Spatial Patterns

Spatial distribution of total catch was nonuniform in lakes (Figure 5). In the connected lakes, fewer fish were collected at the middle collection site than at either end of the lake and, in both lakes, the total abundance at the near and

Table 2
Larval (L) and Juvenile (J) Fish Caught in Larval Light Traps [Number (Percent Total Catch for that Stage Per Lake)] in Three Oxbow Lakes in Mississippi (Black Lake, Quitman County; White Lake, Tallahatchie Co.; Campbell White Lake, Quitman County)

Taxon	Stage	Black 72[1]	White 72[1]	Campbell White 72[1]
Cyprinids	L	105 (0.080)	136 (0.101)	16 (0.014)
	J	4 (0.014)	10 (0.069)	0
Dorosoma cepedianum	L	22 (0.016)	415 (0.307)	889 (0.772)
	J	24 (0.086)	0	6 (0.545)
Pomoxis	L	1,093 (0.834)	751 (0.557)	203 (0.176)
	J	102 (0.364)	110 (0.759)	0
Lepomis	L	4 (0.003)	2 (0.001)	2 (0.002)
	J	4 (0.0014)	10 (0.069)	0
Labidesthes	L	36 (0.027)	5 (0.004)	1 (0.001)
	J	3 (0.011)	6 (0.041)	4 (0.364)
Micropterus	L	30 (0.023)	0	0
	J	131 (0.468)	0	0
Gambusia affinis	L	1 (0.001)	1 (0.001)	1 (0.001)
	J	0	1 (0.007)	1 (0.091)
Percids	L	10 (0.007)	17 (0.013)	3 (0.003)
	J	10 (0.036)	8 (0.055)	0
Catastomids	L	3 (0.002)	1 (0.001)	5 (0.004)
	J	0	0	0
Ictiobus	L	0	11 (0.008)	12 (0.010)
	J	0	0	0
Fundulus	L	0	2 (0.001)	5 (0.004)
	J	2 (0.007)	0	0
Unidentified	L	6 (0.004)	11 (0.008)	15 (0.013)
	J	0	0	0
Total	L	1,310	1,352	1,152
	J	280	145	11

[1] Sample size.

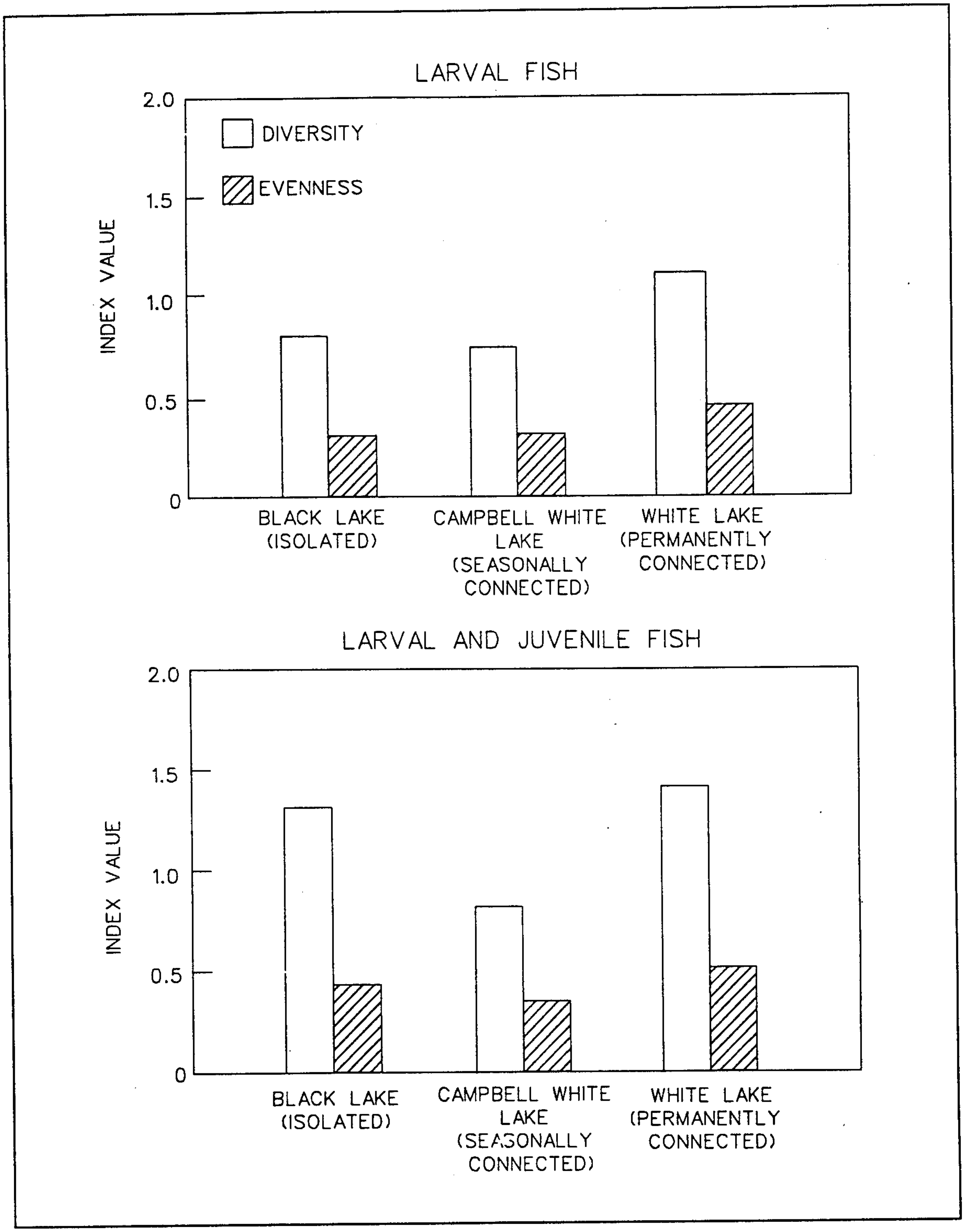

Figure 3. Shannon diversity and evenness indicies of larval and larval/juvenile fish assemblages for oxbow lakes, Tallahatchie River system

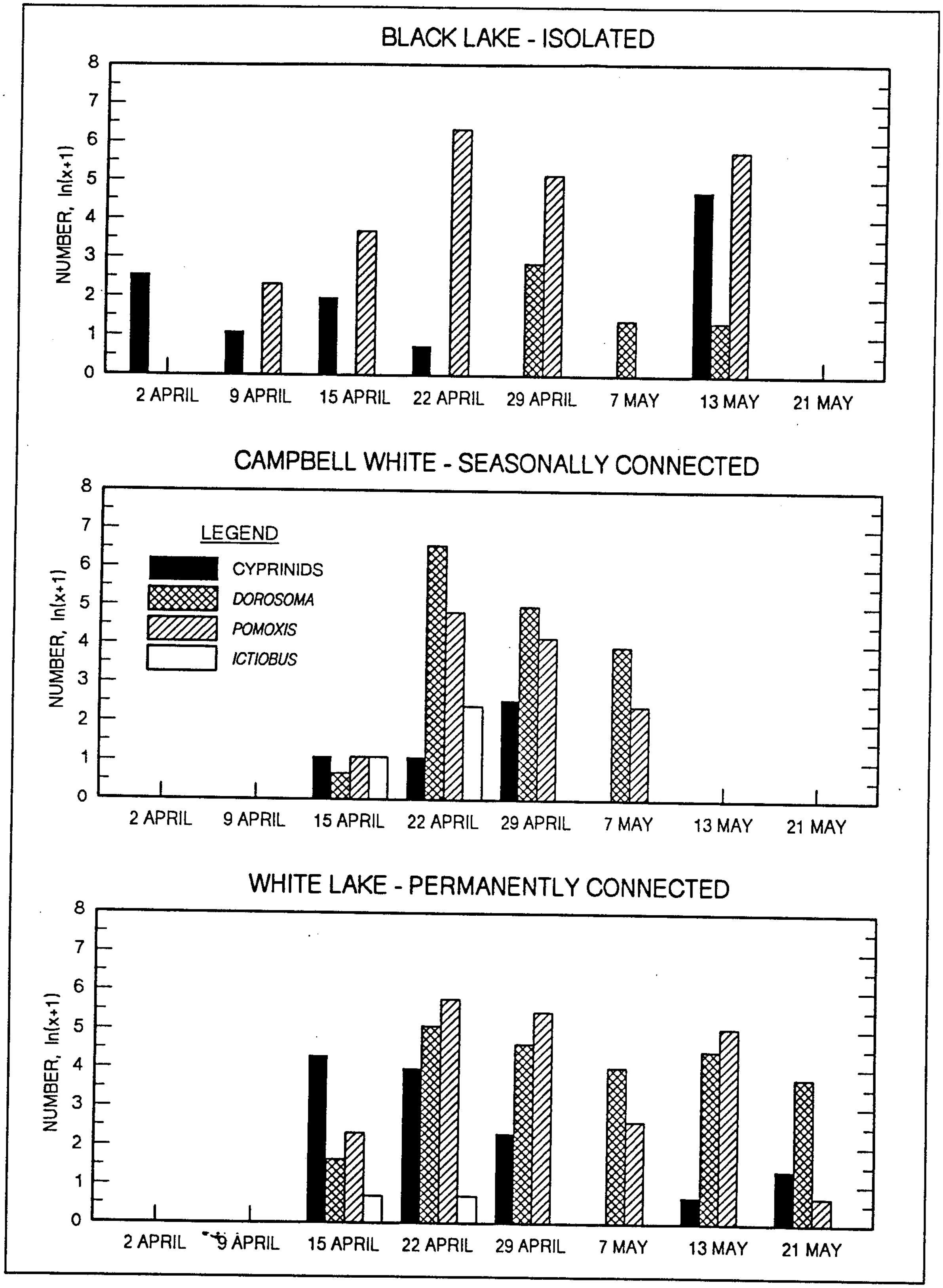

Figure 4. Temporal changes in abundance [ln(number caught + 1)] of four common taxa of larval fish in oxbow lakes during spring 1993. Each date represents a sample size of nine traps

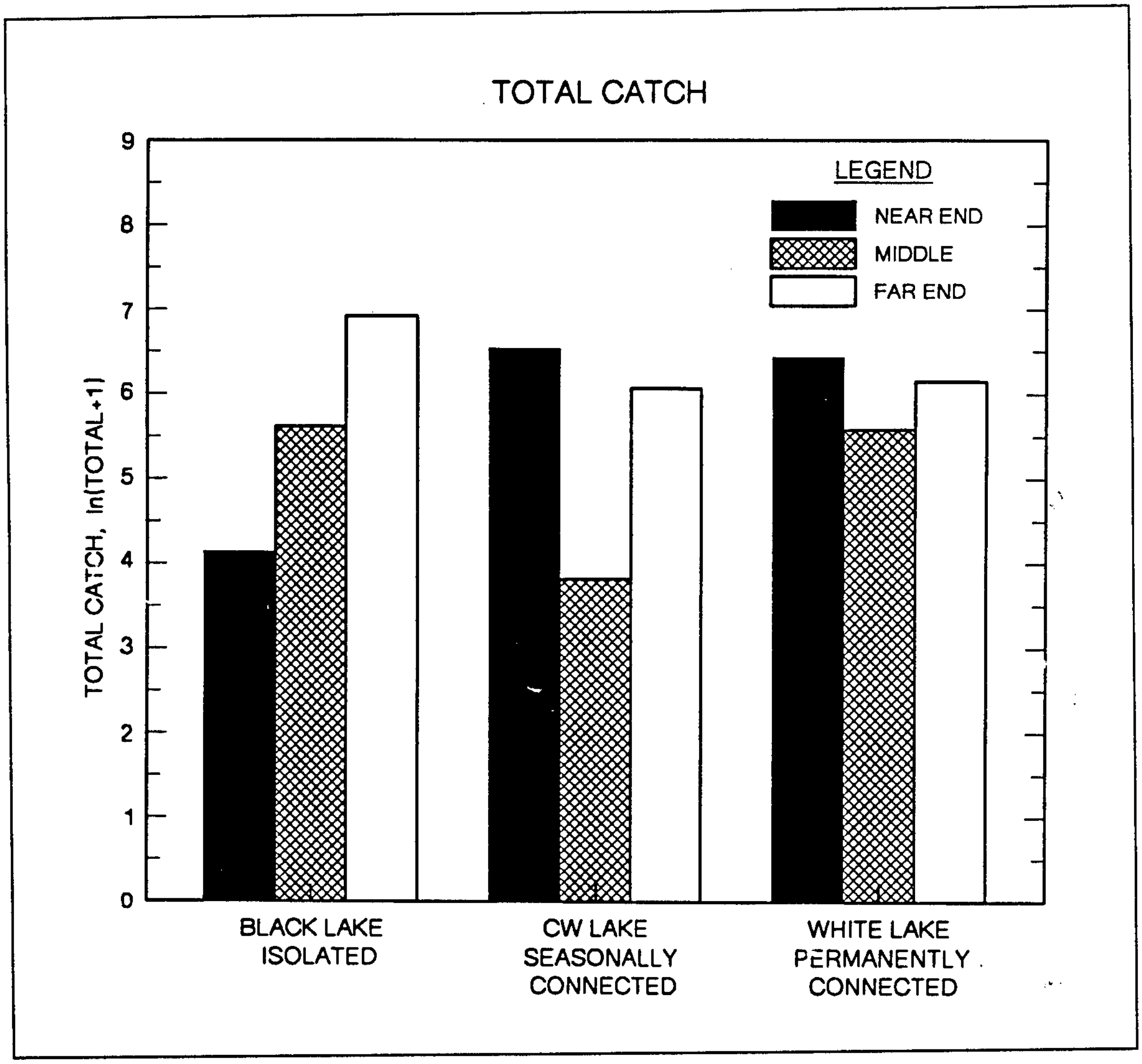

Figure 5. Spatial distribution of total larval fish catch (2 April - 21 May 1993) in Black (isolated), Campbell White (seasonally connected), and White (permanently connected) Lakes (near end = at connection with river (except in Black Lake, see text), middle = lake midpoint, far end = location farthest from near end). Each bar represents a sample size of 24 traps

far ends was the same. There was an increase in total abundance from the south (near end) to north end (far end) of Black lake.

Spatial distribution differed among taxa (Figures 6 and 7). The middle sampling station at Campbell White Lake yielded fewer specimens of all species. Uncommon species (*Micropterus*, *Labidesthes*, Catastomids, Percids) were usually more abundant or only collected at the near end close to the outlet in White Lake. Except for *Dorosoma* and *Micropterus*, abundance was higher at the far end in Black Lake.

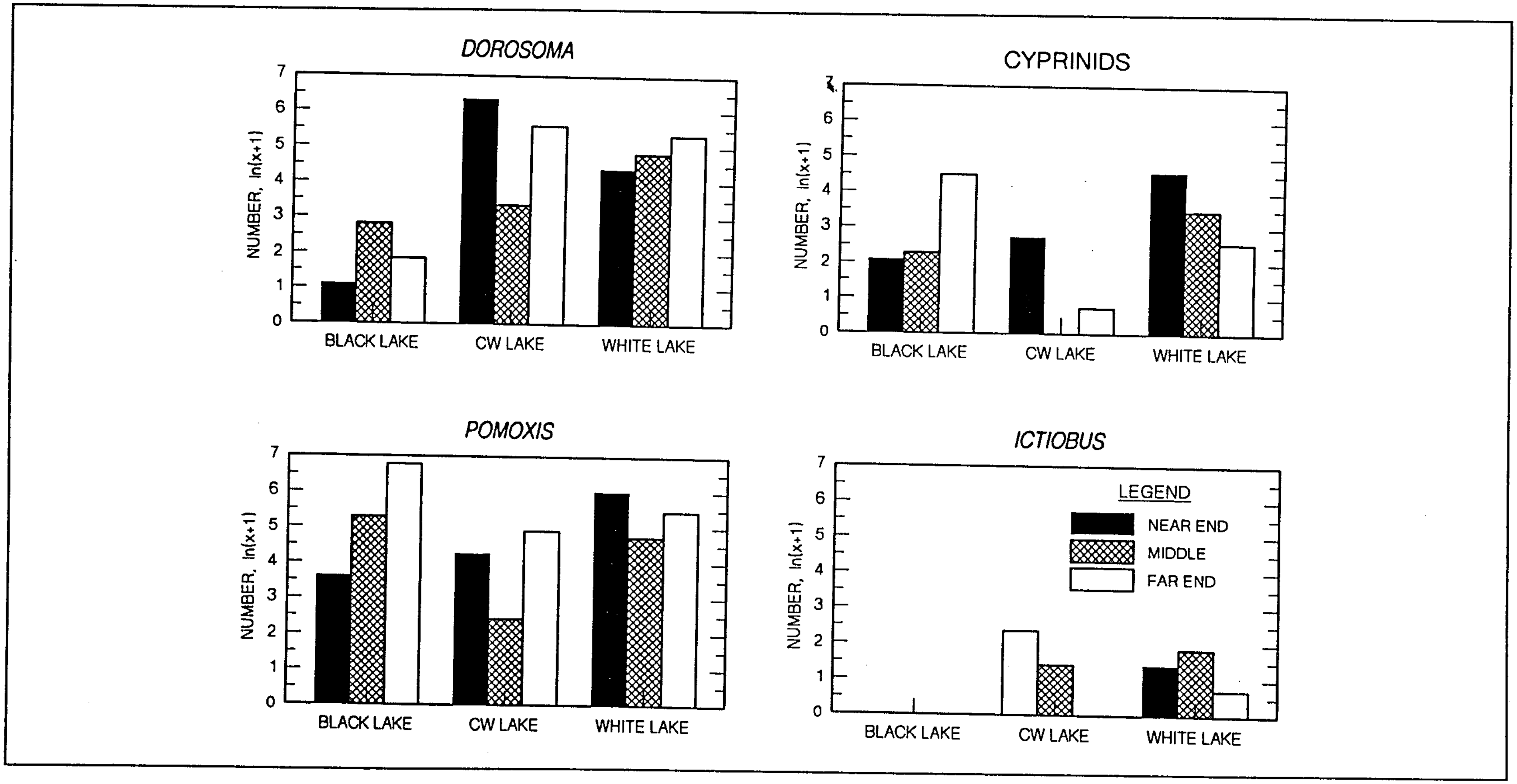

Figure 6. Spatial distribution of shad *(Dorosoma)*, minnows and shiners (Cyprinids), crappie *(Pomoxis)*, and buffalo *(Ictiobus)* larvae collected 2 April - 21 May 1993 in Black (isolated), Campbell White (seasonally connected), and White (permanently connected) Lakes (near end = at connection with river (except in Black Lake, see text), middle = lake midpoint, far end = location farthest from near end). Each bar represents a sample size of 24 traps

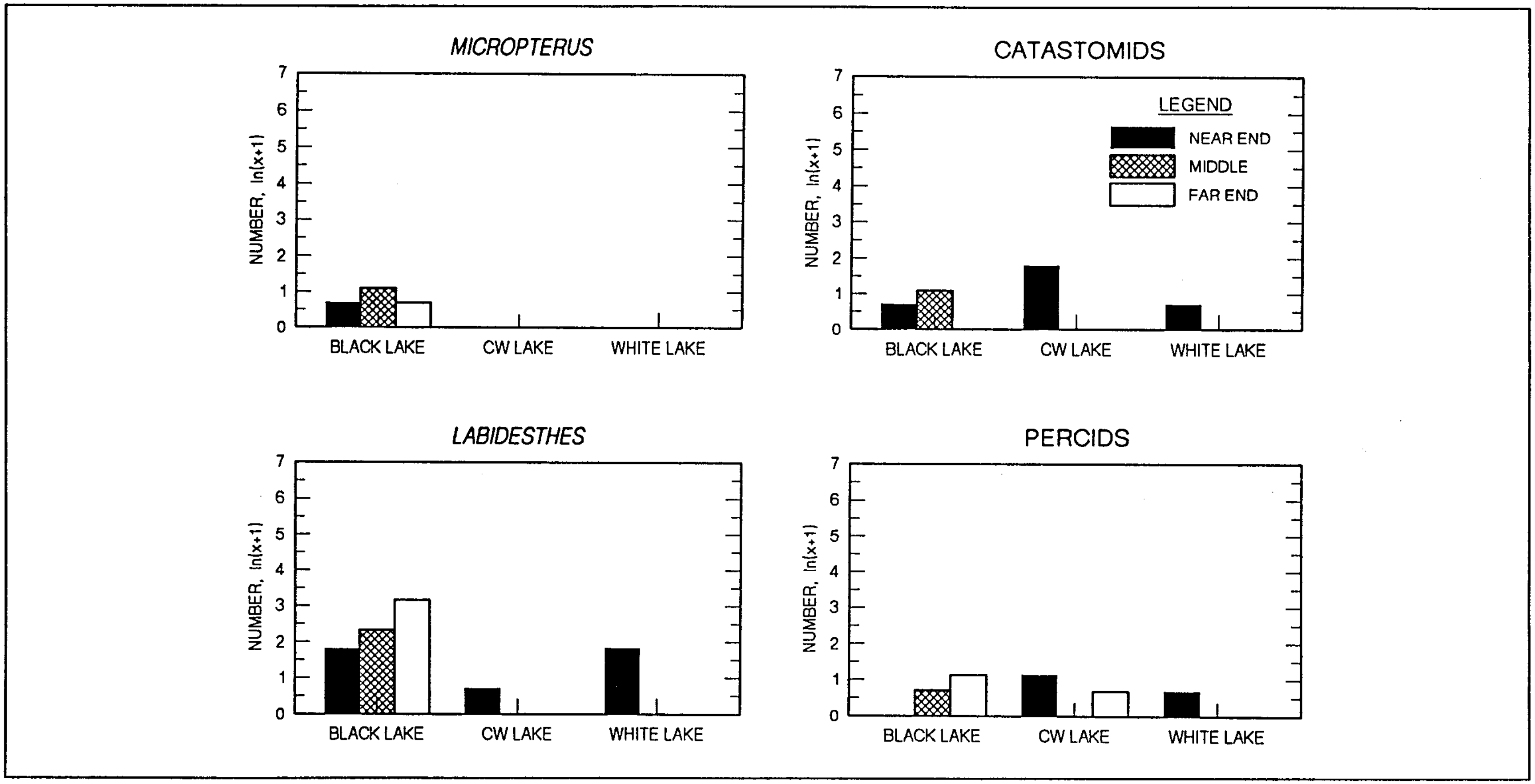

Figure 7. Spatial distribution of black bass *(Micropterus)*, sucker *(Catastomids)*, silverside *(Labidesthes)*, and darter (Percids) larvae collected 2 April - 21 May 1993 in Black (isolated), Campbell White (seasonally connected), and White (permanently connected) Lakes (near end = at connection with river (except in Black Lake, see text), middle = lake midpoint, far end = location farthest from near end)

5 Discussion

Habitat Stability

Oxbow lakes provide relatively stable floodplain habitat during the reproductive season of fishes. They are less likely to experience frequent episodes of high flow, and are more homogeneous in temperature within a sampling period than frequently flooded forest. For example, Turner et al. (1994) reported mean temperature differences as great as 6 °C in April in flooded forests of the Tallahatchie River, whereas the greatest difference between two lakes at a particular sampling time was 2 °C. Dissolved oxygen was also relatively stable, and hypoxia was never observed. However, larval fish abundance correlates poorly to dissolved oxygen in flooded forests, flooded fields, and backwater channel habitats (Turner et al. 1994)

Species Richness and Diversity

Oxbow lakes support moderate numbers of larval fish species, which may reflect the relative stability of physical conditions in these floodplain habitats. The 11 taxa collected in the oxbow lakes are lower than reported by Turner et. al (1994) for a study also conducted in the Tallahatchie River (17 taxa). However, species richness was considerably higher (29 taxa by light traps) for collections made in the floodplain of Cache River, Arkansas (Baker and Killgore 1994). Disparity in species richness between these two bottomland hardwood wetlands may be attributable to large tracts of bottomland hardwoods that still exist in the upper Cache River system.

Fish composition in the Tallahatchie River oxbow lakes reflects some of the dominant species found in the Yazoo River system (Killgore and Hoover 1993; Hoover and Killgore 1994), the Mississippi River (Baker, Killgore, and Kasul 1991; Dewey and Jennings 1992), and some southeast impoundments (Van Den Avyle and Petering 1988): gizzard shad, minnows and shiners, sunfishes, mosquitofish. Crappie were particularly abundant and are one of the most important game fishes in oxbow lakes (Robison and Buchanan 1988).

Buffalo, catfish, and gar are also abundant in the Yazoo River system, but were uncommon or absent in collections in this study. Absence of common species is probably due to gear selectivity (e.g., catfish and gar are negatively phototactic during somes stages of ontogeny) and short sampling period. Buffalo have a punctuated spawning strategy in which the larvae appear for only a short time and usually in high abundances. Since buffalo spawn in early spring (Robison and Buchanan 1988; Turner et al. 1994), it is possible that collections were initiated after peak spawning. Species that spawn in late spring and early summer such as shad, sunfishes, and minnows and shiners were better represented in light trap collections. This study also suggests that this group may continue to spawn into the summer if suitable habitat is available in the wetland.

This study suggests that oxbow lakes contiguous with the river have higher species diversity. Contributing factors include accessibility to the floodplain by laterally migrating fish such as buffalo (Bayley 1991) and an ecotone between swift and slackwater habitats that can be exploited by smaller species, particularly minnows and shiners. Connectivity with the river is an important attribute of the floodplain and tends to promote high species richness (Baker et al. 1991). Also, when floodplain water bodies are connected to the main channel, invertebrates and juvenile fishes are washed from the floodplain, thereby providing increased food for mainstream animals (Eckblad et al. 1984; Amoros 1991).

Reduction in hydrosystem connectivity may lead to a decrease in fish production (Whitley and Campbell 1974; Amoros 1991). However, relatively isolated floodplain water bodies receive little sediment and would provide deeper, clear water habitats for certain fish species, such as sunfishes. The isolated lake in this study had lower species diversity of larval fish but shared the same common species as the seasonally connected and permanently connected lakes. Exceptions included species that typically occur in lentic environments—black bass and brook silversides.

Larval Fish Distribution

Strong spatial patterns might be expected in lakes that are connected to a river if spawning habitats are homogeneously distributed within the lake and if fishes migrating into the lake to spawn choose the first available spawning site. In such cases, larval abundance would be higher at the end of the lake connected with the river. In the connected lakes (White and Campbell White), larval fish abundance was highest at the ends. Preference for structure, such as inundated timber, may also result in nonuniform distribution (Van Den Avyle and Petering 1988). For example, some species may avoid the deeper middle lake where predators are often concentrated, and prefer the far ends where structurally complex areas of oxbow lakes prevail, or near the outlet where exchanges between habitats occur. In the isolated lake (Black Lake), larval fish abundance was progressively higher going from near end to far end. A lack of permanent connection in Black Lake may preclude high abundances at

the near end while the far end offers similar refugia from predators as those lakes that are connected.

Conservation

Despite their importance to riverine ecosystems, extensive tracts of bottomland hardwoods continue to be cleared, especially from those lands bordering the Mississippi River and its tributaries (Hesse et al. 1989; Baker, Killgore, and Kasul 1991). Deforestation has become a major issue in the preservation of biodiversity, but the interrelationships of seasonally inundated forest and permanent floodplain water bodies to biotic processes in rivers are poorly understood. Consequently, strategies to conserve and manage these environments are not well developed. This study suggests that one practical solution to managing wetlands is ensuring that permanent water bodies on the floodplain are contiguous with the river during floods.

6 Conclusions

Species Richness

Oxbow lakes in the Tallahatchie River drainage are used as rearing habitat by at least 11 species of fish. However, species richness of the three oxbow lakes is approximately half of that found in the floodplain of Cache River, Arkansas, which has been designated as a wetland (bottomland hardwood) of international importance (Convention on Wetlands of International Importance Especially as Waterfowl Habitat, referred to as RAMSAR). Much of the original bottomland hardwood (BLH) wetlands in the Tallahatchie River floodplain have been converted to agricultural fields which partly contributes to relatively low species richness of larval fish.

Stability

Water elevation, temperature, and dissolved oxygen are relatively stable in oxbow lakes compared with the river. This stability contributes to homogeneity of dominant groups of larval fish regardless of the degree of connectivity.

Spatial Distribution

Spatial distribution of larval fish in oxbow lakes is nonuniform. In lakes connected to the river, larval fish congregate at the ends of the lake. In the isolated lake, abundance was highest at the far end. Access to river and avoiding predation by using structurally complex habitats which typically occur at the ends of lakes may influence spatial distribution.

Species Management

Degree of connectivity may influence presence of certain species. Lakes that are connected had higher numbers of buffalo, which spawn on the floodplain but use rivers as feeding areas and migratory corridors. The isolated lake contained black bass, which was not collected in connected lakes. Thus,

species composition of oxbow lakes may be managed to a certain extent by regulating access from river to lake.

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13. ABSTRACT *(Maximum 200 words)*

Larval fish assemblages were evaluated in oxbow lakes with varying degrees of connection with the Tallahatchie River, a delta stream in the upper Yazoo River Basin in northwestern Mississippi: isolated, seasonally connected, and permanently connected. Eight collections at approximately 7-day intervals were made in each lake between 2 April and 21 May 1993 using Plexiglas larval traps; total sample size was 216.

A total of 3,814 larval and 436 juvenile fish from 11 different taxa were collected during the study; larval fish abundance and species richness were similar among lakes. However, species diversity and evenness were highest in the permanently connected lake. The three lakes differed in the relative representation of the most common taxa found in the study. Larval *Pomoxis* was the most common taxon collected in the isolated and permanently connected lakes, whereas *Dorosoma cepedianum* was most common in the seasonally connected lake. Larval *Ictiobus* were collected in small numbers in the two lakes with connections to the main river channel, whereas larval *Micropterus* were collected only in the isolated lake. Temporal abundance of common taxa also differed among the three lakes with the isolated lake most dissimilar. Spatial distribution of total catch was nonuniform in lakes.

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Oxbow lakes support moderate numbers of larval fish species, which may reflect the relative stability of physical conditions in these floodplain habitats. Species common in the oxbow lakes are also common species in the lower Mississippi River basin: crappie, gizzard shad, minnow and shiners, sunfishes, and mosquitofish. This study suggests that oxbow lakes contiguous with the river have higher species diversity than those that are isolated due to accessibility to floodplain by laterally migrating fish such as buffalo and an ecotone between swift and slackwater habitats that can be exploited by smaller species, particularly minnows and shiners. Thus, one practical solution to managing wetlands is ensuring that permanent water bodies on the floodplain are contiguous with the river during floods.